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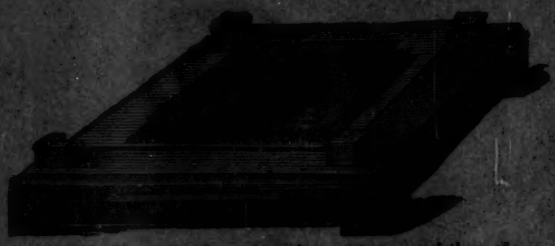

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PHYTOPATHOLOGY

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PUCCINIA SUBNITENS AND ITS AECIAL HOSTS. II

ELLSWORTH BETHEL

Recent culture work, field observations, and collections have greatly extended the number of aecial hosts of *Puccinia subnitens* Diet. The writer published his cultures with this rust for 1916 (see Phytopathology, **7**: 2, 92–4) on 22 species of hosts, and 15 genera in 6 families. A number of successful cultures were made in the summers of 1917, and 1918, and several additional hosts were obtained in Colorado. A hasty trip through the Southwest, in the spring of 1918, resulted in making four collections, two in California, and one each in Arizona and New Mexico, which added a large number of aecial hosts, so that the total number for the four states, namely, California, Colorado, Arizona, and New Mexico, at the close of this season (1918), is 76 species and 48 genera belonging to 19 families.

In the following list, those marked by an asterisk have been verified by cultures by the writer.

AECIAL HOSTS

1. Polygonacae. *Polygonum aviculare** L., *P. ramosissimum** Michx., *P. erectum** L., Colo.; *Eriogonum subreniforme* S. Wats., *E. trichopodum* Torr., *Rumex hymenosepalus* Torr., Ariz.

2. Chenopodiaceae. *Chenopodium Fremontii** S.Wats., *C. hybridum** L., Colo.; *C. album** L., *C. incanum** (S.Wats.) Heller, *C. leptophyllum** Nutt , *C. salinum** Standl., *C. pratericola** Ryd., Ariz., Colo., N. Mex.; *C. rubrum* L., Ariz., N. Mex.; *C. murale* L., Ariz.; *Monolepis Nuttalliana** (R. & S.) Englm., *Kochia scoparia** (L.) Schrad., Colo.; *Salsola pestifer** A. Nels., Colo., Ariz.; *Atriplex hastata** L., Colo.; *A. rosea** L., Ariz., Colo., N. Mex.; *Beta vulgaris** L., *Suckleya Suckleyana* (Torr.) Ryd., Colo.

3. Amaranthaceae. *Amaranthus retroflexus** L., *A. blitoides** S. Wats. *A. graecizans** L., Colo.

4. Nyctaginaceae. *Abronia fragrans** Nutt., *A. elliptica* A. Nels., Colo.; *A. pinetorum* Jepson, Calif.; *Quamoclidion multiflorum* Torr., Ariz.

5. Alsinaceae. *Spergularia* (*Tissa*) *Clevelandii* (Greene) Robn., *S. macrotheca* Heyhn., Calif.

6. Caryophyllaceae. *Silene antirrhinum* L., Ariz.

7. Fumariaceae. *Capnoides* (*Corydalis*) *aureum** (Willd.) Kuntze, Colo.

8. Brassicaceae. *Thlaspi arvense** L., *T. coloradense** Ryd., *Stanleya glauca** Ryd., *Brassica* nigra* L., *Sinapis arvensis** L., *Capsella Bursa-pastoris** Medik., *Sisymbrium altissimum** L., *Roripa palustris** (L.) Bess., *Raphanus sativus** L., *Camelina microcarpa** Andrz., Colo.; *Lesquerella Gordoni* (Gray) Wats., *Draba cuneifolia* Nutt., Ariz.; *Erysimum asperinum** Ryd., Colo., Ariz.; *Lepidium densiflorum** Schrad., *L. medium** *Greene*, Colo.; *L. lasiocarpum* Nutt., *L. hirsutum* Ryd., Ariz.; *Sophia pinnata** (Walt.) Howell, *S. incisa* (Engelm.) Greene, Colo.; *S. ochroleucra* Wooton, Ariz.; *Nasturtium officinale** L., Ariz., Colo.

9. Capparidaceae. *Cleome serrulata** Pursh., Ariz., Colo., N. Mex.; *Cleomella angustifolia* Torr., Colo.

10. Loasaceae. *Mentzelia nuda* (Pursh.) T. & G., Colo.; *M. multiflora* (Nutt) Gray, Ariz.

11. Onagraceae. *Sphaerostigma chamaenerioides* (Gray) Small, Ariz.

12. Gentianaceae. *Centaureum calycosum* (Buehl.) Fernald, N. Mex.

13. Polemoniaceae. *Gilia Bigelovii* Gray, *G. inconspicua* (Smith) Dougl., Ariz.

14. Hydrophyllaceae. *Phacelia crenulata* Torr., Ariz.

15. Heliotropiaceae. *Heliotropium spathulatum* Ryd., Ariz., N. Mex.

16. Boraginaceae. *Lappula occidentalis** (S. Wats.) Greene, Colo.; *L. texana* (Scheele) Greene, *Cryptanthe crassisepala* (T. & G.) Greene, *C. angustifolia* (Torr.) Greene, *C. pterocarya* (Torr.) Greene, *Pectocarya linearis* D. C., Ariz.

17. Verbenaceae. *Verbena ciliata* Benth., Ariz.

18. Solanaceae. *Nicotiana trigonophylla* Dunal, *Datura meteliodes* D. C., *Petunia parviflora* Juss., Ariz.; *Quincula lobata* (Torr.) Raf., Colo.

19. Lobeliaceae. *Nemocladus ramosissimum* Nutt., Ariz.

The sequence of families in the foregoing list is that of the phanerogamic floras. The family groups, and sequence are significant, as was indicated in the previous article (*loc. cit.*), and furnish clues for the search for other host families. The writer has included only his own collections which from cultures and field observations seem unquestionably to be related to this rust.

The chief telial host for *Puccinia subnitens* is *Distichlis spicata* though there are two or three other grass hosts on which the rust has been rarely collected. The aecia are not uncommon on Cleome and various species of Chenopodium on the arid mesas of New Mexico and Arizona remote

from Distichlis, and it is probable that a rust on species of Pleuraphis (Hilaria) associated with them should be referred to *Puccinia subnitens* since it is morphologically very similar to this rust, and for the reason that there are apparently no other grass rusts present which could be related to these aecia. However, no cultures have been made to establish this relationship. Dr. J. C. Arthur suggests (*in litt.*) that one of the rusts on Aristida may be this species. A discussion of the probable telial hosts may be omitted at this time, since this article is concerned only with aecial hosts, and all the collections herein listed were obtained in close proximity to the rust on Distichlis.

Distichlis spicata is a very common grass of the Great Plains, and is especially abundant on the Pacific coast. It is the chief grass of the alkaline flats of Colorado, the Great Basin of Utah and Nevada, and the Colorado and Mojave deserts; in fact, it is abundant throughout the Southwest in marshy places where the soil is either saline or alkaline. It is not uncommon along the Atlantic Coast, and occurs also in Mexico, Central America, and South America.

The Distichlis grass in the Western States is almost always badly rusted. In fact, it would be rare indeed to find even a small area where the rust is absent, since some of its alternate hosts are always present. So far as examined, the rust in the interior region is all *Puccinia subnitens* with the exception of one collection in Arkansas. On the Pacific Coast, this species is largely supplanted by *Uromyces Peckianus* Farl., a correlated rust having (so far as known) Chenopodiaceous aecial hosts. The writer has done no culture work with the latter species, but collected the aecia on *Salicornia ambigua*, *Atriplex rosea*, *Chenopodium album*, and *C. murale* at Monterey, California, May 7, 1918. In the collections of telia at this place, it was a matter of especial interest to find 2-celled spores in the Uromyces sori, identical with the teliospores of *Puccinia subnitens*. The Uromyces and Puccinia probably sometimes occur intermixed on the Pacific Coast, as is the case with various rusts in the middle West, such as the Uromyces and Puccinia of Spartina, and the various rusts of Andropogon. Cultures with these intermixed rusts have frequently led to erroneous deductions.

There are three rusts which very frequently are associated with *Puccinia subnitens* which have aecia very similar to those of the latter rust and may be easily mistaken for it. They are *Uromyces Polygoni* (Pers.) Fckl. on *Polygonum aviculare*, *Uromyces Chenopodii* (Duby) Schroet., on *Dondia multiflorum*, and *Puccinia luxuriosa* Syd., on *Sarcobatus vermiculatus*. The writer has furnished sets of the aecia of all these rusts to North American Uredinales, as well as sets of the aecia of *Puccinia subnitens* on ten hosts so that those who may be interested may compare them.

In the arid regions of the West there is seldom enough moisture to germinate all of the teliospores at any one time. The telia on leaves lying on the ground will germinate first, while those on the erect leaves will germinate later, some of the spores retaining their viability until late summer, as has been frequently proved by cultures. There is therefore a crop of aecia for many rusts in this region following each period of wet weather throughout the summer. This is especially true of *Puccinia subnitens*. Some hosts, such as Salsola, Kochia, and certain Polygonums are susceptible to infection only when very young; others, such as Cleome, and some species of Atriplex, and Chenopodium are susceptible even when the plants are in the fruiting stage. Aecia were observed on *Cleome serrulata* in Colorado and New Mexico throughout the past summer, the last collection being made September 23, 1918, in the San Luis Valley, Colorado.

A locality should be visited at successive periods in order to get all the aecial hosts. The aecia appear first on young plants of Salsola, Polygoums, Lepidiums, and certain Chenopodiums. By the time that some of these species have lost their susceptibility, other host species will have developed. A number of aecial hosts are slow in germinating and do not appear above ground until certain other hosts have lost their susceptibility to infection.

The writer conducted a series of cultures to determine whether there were any racial tendencies in this rust, with the result that there was no evidence of such. Telia from the desert regions of Arizona, and from marshy places in Colorado were used for cultures. Aecial hosts, whether xerophytes, such as *Chenopodium incanum* and species of Cryptanthe, or hydrophytes, such as the common water cress and *Roripa palustris*, were equally infected no matter what the source of the telia. The same was true with the halophytes, such as *Chenopodium salinum*, and species of Atriplex. It is obvious that as in most heteroecious rusts, some hosts are more susceptible to infection than others, but the degree of susceptibility of the various hosts to this rust seems to depend chiefly upon their age.

In the spring of 1918, while doing work in forest pathology, the writer made four collections in the Southwest. There was no available time for visiting the large areas of Distichlis in California where the telia had been observed in previous years, and the few collections were made incidentally in connection with the pathological work on forest trees. At Long Beach, California, aecia were found in abundance on *Spergularia Clevelandii* on vacant lots, April 5. Distichlis was the only grass observed nearby, and though no cultures were made, there is no doubt in the opinion of the writer, that the aecia (see specimens in N. A. U., No. 2068) are related to *Puccinia subnitens*, since telia of the latter rust were found in close proximity, and sometimes even touching the Spergularia. Dr. Arthur places

the aecia of Spergularia of the Atlantic Coast with *Uromyces Spartinae* Farl. (see Mycologia **9**: 5, 294–312), however, no Spartina grew at Long Beach, nor at San Jacinto, where aecia were collected on another species of Spergularia adjacent to telia. With the aecia at San Jacinto, there were aecia on Abronia, a common and well known host genus in Colorado.

An interesting collection was made at Farmington, New Mexico, July 27, 1918. The writer had the valuable assistance of Mr. N. Rex Hunt of the office of Forest Pathology in making this collection. One aecial host is of especial interest, namely, *Centaureum calycosum* of the Gentian family. Other hosts were *Atriplex rosea*, *Cleome serrualata*, *Chenopodium rubrum*, *C. leptophyllum*, *C. incanum*, *C. pratericola*, and *C. album*.

Early in November 1917, the writer, in the company of Dr. G. G. Hedgcock of the office of Forest Pathology, found an area of Distichlis in a very unusual place, near the town of Cottonwood, Arizona. Though not far from the river, desert conditions prevailed, and various xerophytes comprised the fall flora. The Distichlis was black with rust, the infection being the heaviest ever observed by the writer (see specimens in N. A. U. No. 1968), and it was a matter of no little speculation as to what plants could serve as aecial hosts in such a place.

On the 23rd of May, 1918, the writer, in search for the Pinon Blister Rust, had occasion to visit this locality again. The spring in this region had been one of unusual drought and high winds so that much of the vegetation had been killed. It was therefore a matter of great surprise to find plants of nearly every species on this area, covered with aecia of *Puccinia subnitens*. On an area of only two or three acres, the aecia were collected on 37 species, 27 genera in 15 families. The area is probably not more than 50 yards wide and 200 yards long, though it is not all covered with Distichlis. No other grass was observed except an occasional clump of Sitanion. The arborescent flora consisted of numerous trees of *Acacia Greggii*, and the common salt bush, *Atriplex canescens*. All the collection for Arizona in the list of aecial hosts were collected at this place. Thefew hydrophytes, and halophytes such as the water cress, and *Heliotropium spathulatum*. and some Chenopods, were collected along an irrigating ditch on the west side of the area. The irrigating ditch is used to irrigate the ranches below and none of the water from it reaches the area where most of the aecial collections were made. It will be noted that many of the plants listed for this place are those common to the desert, or at least to very arid regions. It is almost unbelievable that so many species of plants bearing aecia should be found in one locality, and especially on so small an area. It is to be hoped that uredinologists may visit this most remarkable locality in a more favorable season. The time for collecting was very short, and doubtless other hosts will be found under more favor-

able circumstances. The place is about one mile northwest of Cottonwood at the base of the mesa on the north side of the Verde river. As there are no bridges across the river, the place is not easily reached except at time of low water.

Most heteroecious rusts limit their aecial hosts to species of one genus, though they occasionally extend to several genera of a single family, but it is very rare for a rust to find congenial alternate hosts in more than one family. *Puccinia subnitens* is a notable exception, and has aecial hosts extending through almost the entire range of herbaceous Dicots, that is, from Polygonaceae to Lobeliaceae.

It seems to be a very primitive rust with little host specialization or racial tendencies. The fact that so many host species are recorded for the Chenopodiaceae and Brassicaceae does not mean that these families are better hosts than others. It simply means that there are more species in these families which have the same habitat as Distichlis, and more often associated with the rust than species of other families.

It is probable that aecial hosts will be found in various other families, expecially in the Papaveraceae, Scrophulariaceae, Portulacaceae, Labiatae, and Valerianaceae. It is doubtful if hosts will be found in the Compositae, and in most families which contain only arborescent species. It is obvious that those families which have only species which grow remote from the telial hosts of this rust will not furnish natural hosts, though it is probable that the rust may be grown on some of them. Cultures have been almost uniformly successful when made on suspected hosts. More than 40 per cent of the species listed have been verified by cultures by the writer, Negative results were obtained with cultures on *Sarcobatus vermiculatus, Atriplex canescens, Salicornia rubra, Dondia nigra* and a western form of *Atriplex hastata*. The typical eastern *A. hastata* is highly susceptible to infection as was determined through cultures made by the writer during the past summer.

It is obvious that if four hasty collections in three states, namely, California, Arizona, and New Mexico, should add 34 species and 22 genera in 12 families, that further work in the Southwest should greatly augment the list as to species and genera, and probably add several more families to the already long list of aecial hosts.

The foregoing data are derived entirely from the writer's collections and observations. During the latter part of December, 1918, the collections of Distichlis in the herbaria of the Missouri Botanical Garden, and the National Herbarium, as well as Dr. Arthur's large collection of rusts, were examined. In the National Herbarium there was found a specimen of *Distichlis spicata* infected with *Puccinia subnitens* which had been collected in Peru by Mr. and Mrs. J. N. Rose June 26, 1914. This collection ex-

tends the range of this species of rust to South America, this being the first report of its occurrence south of the United States.

The Arthur collection, while not containing as many host families as that of the writer, has a very large number of aecial hosts occurring in not fewer than a half dozen families. There are more than a hundred and fifty collections of aecia from the western states; both aecial and telial collections are represented from each of the seventeen states west of the ninty-fifth meridian, which shows its wide distribution and abundance in the trans-Mississippi region. Four genera which have not been collected by the writer are of especial interest. They are the following: *Nitrophila occidentalis* (Chenopodiaceae) from Nevada, *Allionia melanstricta* (Nyctaginaceae) from Arizona, *Isomeris arborea* (Capparidaceae), and *Thelypodium laciniatum* (Brassicaceae) from California.

Quite a number of Aecidiums have been described which are referable to *Puccinia subnitens*. Cultures by the writer in 1917 established the relationship of *Aecidium fumariacearum* Kell. & Swingle, and *Aecidium Corydalis* Webber to this species. The relationship of *Aecidium cleomis* Ell. & And., *A. Lepidii* Tr. & Gall., *A. Elisii* Tr. & Gall., and *A. Abroniae* E. & E., to this rust has been established by cultures by both Arthur and the writer. *Aecidium Isomerium* Pk., and the Aecidiums on Heliotropium of the western states such as *A. Heliotropii* Tr. & Gall., and *A. biforme* Pk. should doubtless be referred to this species. *Aecidium guatemalensis* K. & K. may belong here. It occurs on Heliotropium in Guatemala in a region where Distichlis is found. The writer has not studied this collection, and had no opportunity to investigate this rust when collecting in Guatemala. *Aecidium caspian* Jacz. on Heliotropium from Transcaspia may also be the aecial stage of *Puccinia subnitens* since Jaczewski in his description remarks that it is very similar to *A. biforme* if not identical with it. It is possible then that this ubiquitous rust of western North America may also be found in Europe, though so far as the writer is aware, no collection of telia has been reported.

Not many collections from the Atlantic Coast have been examined, but collections of both the aecial and telial stages have been seen from most of the states from Maine to Delaware.

Cultures made by the writer with *Aecidium Sarcobati* Pk. (see previous article. *loc. cit.*) show that it is related to *Puccinia luxuriosa* Syd. on Sporobolus. Though it has aecia and telia quite similar to those of *Puccinia subnitens*, many cultures and field observations fail to indicate any relationship, hence the writer for the present thinks best to treat it as a distinct species. The aecia of *A. Sarcobati* are uniformly long cylindrical, and the peridia are lacerated so that it has somewhat the appearance of a Peridermium and was first described as *Peridermium gracile*

by Harkness. (See specimens in N. A. U., No 1949) *Puccinia luxuriosa* is sometimes found in regions where there is no Sarcobatus, thus indicating other aecial hosts which have not thus far been discovered.

The first Aecidium to be described which is referable to *Puccinia subnitens* is *Aecidium biforme* Pk., Am. Nat. 9 : 351. 1875. It follows that this rust would naturally take the name of *Puccinia biformis*, but this name is in use, having been applied to a South American rust on Rumex. The nomenclature may well be left in abeyance until further investigations have been made of certain described Aecidiums, and several grass rusts, some of which are doubtless referable to this species.

The following excellent description of *Aecidium biforme* by Peck illustrates the extreme variability of the aecia.

"Peridia clustered, some short with wide entire mouth, others elongated with mouth more or less lacerated, the wall-cells mostly pentagonal or hexagonal; spores subglobose, golden yellow, 0.0007 to 0.0008 inch in diameter. Parasitic on both sides of the leaf of *Heliotropium Curassavicum* L. Collected by Dr. Parry at St. George, Utah, May, 1874.

The peculiar feature of this species is in the peridia, which are either long or short, and equally abundant on both sides of the leaf, projecting each way from the same subiculum."

The aecia are very variable on different hosts, and often vary on the same plant. Plants with thick, succulent leaves, such as *Chenopodium rubrum*, *Nicotiana trigonophylla*, and *Abronia fragrans*, will usually bear short, densely aggregated aecia. On plants which have linear leaves such as the Gilias and Borages, the aecia are very long and slender and often lacerated. Both the long filiform, and the short clustered aecia are found on the same plant of certain host species.

The extreme variability of the aecia accounts for the many Aecidiums which have been described for *Puccinia subnitens*, and it is probable that there are several unattached Aecidiums which should be referred to this rust. Some of the following which have not been examined by the writer will probably be found to belong here if one may judge by the published descriptions. Attention is here directed to them with the hope that they may be investigated and their true status be determined. They are *Aecidium Drabae* TR. & Gall. on Draba, New Mexico; *A. Cockerellii* Arth. on Chamaesaracha, New Mexico; and *A. plenum* Arth. on Argemone, Oklahoma.

The limits of this paper will not permit a complete list of the aecial hosts with their localities, nor the many localities for the occurrence of the telia as obtained from an examination of phanerogamic herbaria. The number of aecial collections examined by the writer makes a grand total of 84 host species, in 52 genera belonging to 19 families. The following records are those known for four states up to January 1, 1919.

	Families	*Genera*	*Species*
California	5	5	7
New Mexico	7	10	14
Colorado	9	27	42
Arizona	15	28	39

Specimens of both aecia and telia of *Puccinia subnitens* from any locality will be appreciated. Also culture material of both this rust and *Uromyces Peckianus* is very much desired.

The writer is under especial obligation to Dr. Paul C. Standley of the National Herbarium for the determination of the hosts collected in New Mexico, and Arizona. Grateful acknowledgment is also tendered to the following persons whose courtesies have greatly facilitated the investigation of this rust. Prof. A. O. Garrett, and Prof. E. M. Hall for collections of aecia and telia, and culture material from St. George, Utah, Dr. J. M. Greenman of the Missouri Botanical Garden, Dr. Hitchcock and Mrs. Chase of the National Herbarium, and Dr. J. C. Arthur, and Dr. H. S. Jackson of Purdue University. Dr. Arthur's generous permission to use unpublished data is especially appreciated.

STATE MUSEUM,
DENVER, COLORADO.

THE ADVISORY BOARD OF AMERICAN PLANT PATHOLOGISTS

G. R. Lyman

The American Phytopathological Society adopted the following resolution at Baltimore, December 28, 1918:

Resolved, that there be established a permanent committee to be called the Advisory Board of American Plant Pathologists representing the American Phytopathological Society. The personnel of this Board shall be six members appointed by the Council, two each for periods of one, two and three years, and thereafter two each year for a three-year term. These members shall represent the United States Department of Agriculture, and the following regions: Northeast, South, Middle West, Pacific Coast and Canada. The chairman of the Board shall be elected annually by the Board.

The duties of the Board shall be:—(1) To represent the American Phytopathological Society before the National Research Council. (2) To prepare and distribute to the members an annual list of the active phytopathological projects in progress in the country. (3) To arrange for conferences of groups of workers on related subjects at the annual meetings or elsewhere. (4) To confer with workers in related fields, i.e., entomology, genetics, horticulture and agronomy, to promote joint efforts on our common problems. (5) To promote international relations in phytopathology. (6) To take up such other problems as the Board may find necessary, subject to the approval of the Council.

The completed plans of this Board shall be presented to the Council of the Society for approval before being carried into effect.

The following were appointed on the Advisory Board for the year 1919: G. R. Lyman, chairman, pathologist in charge of the Plant Disease Survey, Bureau of Plant Industry, representing the United States Department of Agriculture (elected for three years): C. R. Orton, secretary, professor of plant pathology at Pennsylvania State College, State College, Pa., representing the northeastern states, (elected for two years): H. W. Barre, director of the South Carolina Experiment Station, Clemson College, S. C., representing the southern states, (elected for one year): H. S. Jackson, pathologist at the Purdue Experiment Station, La Fayette, Ind., representing the middle western states, (elected for two years): H. P. Barss, professor of plant pathology at the Oregon Agricultural College, Corvallis, Ore., representing the mountain and Pacific coast states, (elected for one year): P. A. Murphy, pathologist at the Plant Pathological Laboratory, Charlottetown, Prince Edward Island, representing Canada, (elected for three years).

The Advisory Board is the direct successor of the War Emergency Board of 1918. The War Board was appointed by the American Phytopathological Society at Pittsburgh in December 1917, because the pathologists assembled there, recognizing the emergency created by the world war, believed that the efficiency of pathological work would be increased by promoting coöperation and coordination of effort, especially with reference to the production and conservation of food crops. They also believed that a committee from their own ranks could accomplish certain phases of this work more effectively than could any existing agency. The work of the War Emergency Board is already known to you. That Board had a large measure of success, not only in actually coordinating pathological work of a war emergency nature but also in fostering the spirit of coöperation amongst pathological workers generally, thus laying a foundation for more effective work in the future. Toward the close of 1918 President E. M. Freeman of the American Phytopathological Society conducted a referendum to determine the sentiment of the members relative to continuing certain phases of the War Board work during peace times. The vote was more than ten to one in favor of such continuation. Accordingly at the annual meeting at Baltimore, December 28, 1918, the Society adopted the resolution given above.

The Advisory Board was appointed because the American Phytopathological Society, after one year's experience with the War Board, believed that coöperative work should be continued. Yet it must be admitted that organized coöperation amongst plant pathologists on a peace basis is still an experiment. The scientific workers' training and experience tend to develop their individuality and to render it difficult for them to work in groups after the manner of business men. Recognizing this , Mr. Elihu Root has recently charged scientists with having organized everything except themselves. It is true that the past months have seen a marked growth of sentiment in favor of coöperation in scientific effort. Moreover, plant pathologists have always coöperated with one another to a considerable extent,—the nature of their problems making this necessary. Yet such coöperation has always been sporadic and usually limited to small groups of workers. While few, if any, pathologists oppose cooperation in principle, many have been fearful of some of its effects when put into more general practice. The proposal that coöperation be organized on a broader basis in order that certain problems may be solved more certainly and expeditiously rouses the fear that by so doing we may limit the freedom of individual initiative and may jeopardize the security of ownership of the results of research which are so dear to every investigator.

Hence the most important task immediately before the Advisory Board is to disarm this fear, and to prove to plant pathologists generally that organized coöperation is a safe tool which, when wisely used, will materially increase the efficiency of pathological work without exploiting the individual. The Board proposes to accomplish this end by concentrating on certain projects which in the judgment of pathologists generally are peculiarly adapted to this method of attack, and by organizing and promoting those projects very carefully on a thoroughly democratic basis. Successful work along this line this year will lay a secure foundation for any expansion of our efforts which may be found desirable in the future.

The Advisory Board does not contemplate the reorganization of pathological research as some have feared. This would be undesirable even if it were possible. Many investigators are at their best when working alone, and in the case of most, if not all, pathological problems the first attacks must be made under individual initiative. Yet even here cooperation may materially aid the investigator in supplying material, field data, and other assistance needed in the planning and in the prosecution of his work. The initiation of such coöperation may be left wisely to the will of the investigator, although in many cases the Advisory Board may be able to render assistance when requested.

Many problems which have been thus delimited and clarified under individual attack are found to be so complex and to cover so many fields that only by coöperative assault from different directions can we hope to make substantial progress toward their solution. As an example we may mention the Fusarium problem, which has been attacked by many investigators and nevertheless is growing more complex and more important every day. This problem concerns many hosts and involves every branch of botanical and agricultural science. Such problems require organized attack, and undoubtedly the Advisory Board will find here a large field of usefulness in the future, but there are many difficulties, both personal and administrative, in the way of undertaking such projects at this time.

The Board believes that its most immediate sphere of usefulness lies in the field between laboratory investigation and extension work. Most pathological problems finally reach a stage where the initial results of research need wide testing under varying field conditions to determine their value and applicability in extension work. Only when organized widely on a coöperative basis can such tests be conducted effectively and expeditiously, and the results collated. For many diseases investigators have discovered effective control measures, but in no case have these control measures been tested for all parts of the country so that the extension pathologists everywhere know what to recommend to their growers under the varying local conditions. This statement applies even to such well

known processes as the treatment of cereal grains for smut, the treatment of potatoes for tuber-borne diseases, and the spraying of fruit trees. This field testing still lies in the realm of research, and is properly called field experimentation. It is peculiarly adapted to coöperative organization and only when thus organized may we hope to remedy the present state of deplorable ignorance. Plant pathologists apparently are unanimous in this opinion, and the Advisory Board plans to concentrate its major efforts in this field for the present, believing that success here will disarm any suspicion which now exists and will secure the unanimous support of all pathologists for its future undertakings.

The Board is convinced that a thoroughly democratic procedure in the initiation and prosecution of projects is absolutely essential. It will, therefore, follow the practice of the War Board and call conferences of pathologists and other agricultural workers at such times and places as circumstances appear to render advisable, for the purpose of discussing the pathological problems of certain regions or of particular crops or both. Not only are these conferences of value in many ways and a great stimulus to those in attendance, but the free round-table discussion develops as does no other method those problems on which coöperative effort is desirable. When such a problem appears, those present who are interested group themselves together as coöperators, elect a leader and formulate their plans of campaign which are then presented to other pathologists for their consideration and support.

According to this system the Advisory Board neither formulates the plan of coöperation nor carries it out. All that is in the hands of the cooperators themselves. The functions of the Board are to provide the environment and opportunities for coöperation and to furnish that stimulus and general oversight which are necessary for consistent progress. The Board proposes to assist in every way possible, but in no case to dictate or to command.

Can existing agencies promote coöperation amongst plant pathologists as well or better than the Advisory Board? Is the Board superfluous? I believe not. In the first place no other agency is attempting such work as the Advisory Board has in mind. In the second place I believe no official agency could at this time undertake it with as great prospect of success. The Advisory Board represents the American Phytopathological Society, and has no authority from either state or federal agencies. This lack of authority is the Board's greatest strength in promoting real cooperation. Being without official entanglements, it cannot be charged with entertaining ulterior motives nor with attempting to exploit the cooperators. Fortunately there is a rapid growth in good feeling between state and state and between the states and the federal Department of

agriculture, a good feeling which the War Board and the Advisory Board have done much to promote. Nevertheless it is doubtful whether any official agency at the present time could secure the response which the Advisory Board is assured of because of its neutral position as the representative of the pathologists themselves.

The important question before the Advisory Board at this time is not "Is coöperation desirable?," for the answer has already been given in the affirmative. The question is "Where, when, how and to what extent should coöperation be undertaken?" In answering this question and in developing its plans, the Board requests the advice and criticism of pathologists generally. The Advisory Board was appointed by the American Phytopathological Society and is strictly reponsible to the Council of the Society. The duties assigned the Board are both important and difficult. Their successful accomplishment will require not only the best efforts of all members of the Board, but the active cooperation of all pathologists at all times. Let us all coöperate in wisely promoting coöperation.

BRIEFER ARTICLES

GIANT CROWNGALLS FROM THE FLORIDA EVERGLADES

BEVERLY T. GALLOWAY

WITH PLATE X

Royal Palm Hammock is located in the Florida Everglades, about thirty-five miles south of Miami and fourteen miles south of Homestead. The hammock has an interesting history, which has been quite fully set forth by Mr. John K. Small, in the Journal of the New York Botanical Garden, October, 1916.

We visited the hammock in November, 1918, in company with Mr. Edward Simmonds, superintendent of the Field Station of the Office of Foreign Seed and Plant Introduction at Miami, Mr. J. E. Morrow, of the Brooksville Field Station, and Mr. Edward Goucher, of Washington, D. C. Up to a few years ago the hammock was practically inaccessible except by wading or by boat, but now there is a fairly good road, extending all the way from Homestead.

The hammock may be seen for a distance of several miles, appearing very much like a large island in the midst of the Everglades. The vegetation is remarkably interesting. The most striking plants and the ones that are first noticed are the Royal Palms, towering above the other trees. Most of the vegetation is subtropical, including live oaks, pigeon plum, wild tamarinds, West Indian cherry, the gumbo limbo, the strangling fig (*Ficus aurea*), *Hippocratea volubilis*, sabals, and saw palmettos. According to Mr. Small, more than a dozen kinds of ferns grow in the hammock. There are beautiful large beds of leather fern, royal fern, Boston fern, and sword fern. Mr. Small states that the botanical explorations up to 1916 resulted in the discovery of 241 kinds of plants, from the mushrooms upward, growing naturally in this hammock, 180 of these being flowering plants. Many of the trees are covered with long streamers of Florida moss (Dendropogon), which often hangs down in lengths of 15 to 30 feet.

Formerly the hammock was difficult to penetrate but Mr. C. A. Mosier, the superintendent in charge, has cut many paths, which make the more interesting portions accessible. The ground is a dense tangle of ferns, roots, and decaying vegetation. Over and through this material the roots of many of the plants grow vigorously and in great profusion. The strangling fig is everywhere present and many of the roots are at or near the surface of the ground. On these roots we noticed swellings or gall-like forma-

tions, which attracted our attention on account of their peculiar shape and large size. Many such swellings were also noticed on *Hippocratea volubilis*, which is quite common in the hammock. The galls or swellings on *Ficus aurea* range all the way from half an inch to two to three feet or more in diameter. Those found on *Hippocratea volubilis* are not so large.

Through the kindness of Mr. Mosier we secured one remarkably large specimen of crowngall on *Ficus aurea*. This we succeeded in getting to Washington in good condition. Upon measurement we found the longest circumference of this crowngall to be 5 feet 8 inches and the shortest 4 feet. It weighed 97½ pounds, and so far as we know is the largest on record. The specimen was brought to the attention of Dr. Erwin F. Smith and has been placed among his collections. Cultures from the galls taken from *Hippocratea volubilis* and from *Ficus aurea* yielded characteristic colonies of the crowngall organism, *Bacterium tumefaciens* Sm. & T. Cultures were made from the Hippocratea crowngall by Miss Nellie A. Brown, Doctor Smith's assistant, who succeeded not only in securing the crowngall organism, but also in producing galls from these organisms. Cultures from the large tumor on Ficus also yielded colonies of the organism.

The cell proliferation in these enormous crowngalls appears to be the same as that described by Dr. Erwin F. Smith in his many papers on this subject, especially in the paper on Mechanism of Tumor Growth in Crowngall, published in the Journal of Agricultural Research, Vol. VIII, No. 5. The root to which the large crowngall above referred to is attached is little over 3 inches in diameter. The tumor is a true hyperplasia made up of conjunctive tissues.

U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

PLATE X

FIG. 1. Crowngall on *Hippocratea volubilis* from Royal Park Hammock, southern Florida. Crowngalls are very abundant on surface roots. (Negative 24836, F. S. P. I.—1919.)

FIG. 2. Giant crowngall on *Ficus aurea* from Royal Park Hammock, southern Florida. Weight 97½ pounds; longest diameter 5 feet 8 inches. The root to which this gall was attached is seen near the bottom of the picture. (Negative 24934, F. S. P. I.—1919.)

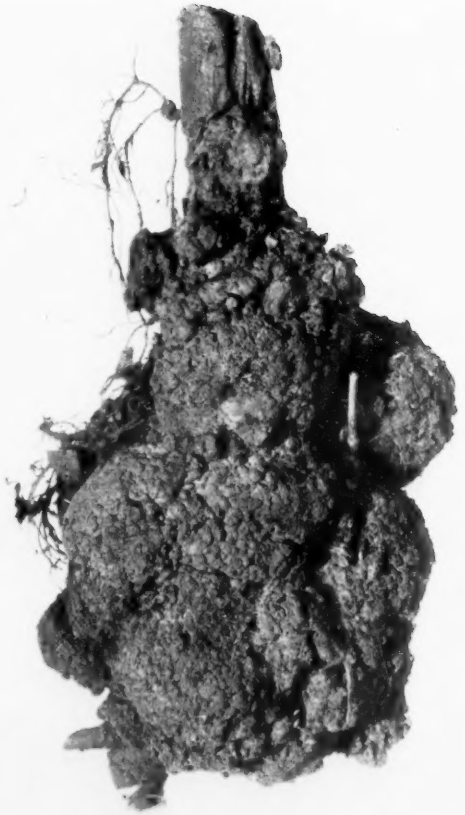

Fig. 1

Fig. 2

Galloway: Giant Crown Galls

A COMPARISON OF THE LATE BLIGHTS OF TOMATO AND POTATO

A PRELIMINARY REPORT

N. J. GIDDINGS AND ANTHONY BERG

WITH PLATE XI

Early in 1913 the authors outlined plans for some experimental work in connection with tomato late blight. We were quite familiar with the potato late blight as it occurred in the New England States and in Wisconsin. In those northern states we had never observed the late blight upon tomato. Under West Virginia conditions, we had seen many tomato fields completely ruined by the late blight; a number of fields where tomatoes and potatoes were both destroyed by *Phytophthora;* and several fields in which potatoes were seriously diseased, although tomato vines among the potatoes or immediately adjacent to them showed no typical late blight symptoms. This circumstantial evidence would indicate that the Phytophthora on the tomato was somewhat different biologically from that usually found upon the potato.

Cultures of *Phytophthora* were secured from tomatoes and from potatoes and comparative inoculation experiments were first attempted in 1915. The alternate loss of plants from fire, frozen pipes, and inadequate pathological greenhouse facilities have prevented our bringing this phase of the problem to a satisfactory conclusion, previous to the winter of 1918–19.

Inoculations made upon potatoes in 1915 indicated that there was some difference between the Phytophthora isolated from potato and that isolated from tomato, while inoculations made upon tomatoes during the spring of 1918 gave very striking evidence of the same kind.

During the winter of 1918–1919 several series of inoculations were made on both tomatoes and potatoes. This article will cover only the work with four sets of tomato plants, although an equal number of potato plants was inoculated in each instance, and many other series of inoculation experiments have been conducted in connection with other phases of the problem.

Three strains of *Phytophthora infestans* were used in this work. Culture I was secured from diseased tomato fruits collected at Elkins, W. Va., culture II was secured from diseased potatoes collected at Davis, W. Va.; and culture III was secured from diseased potatoes which were sent to us from Maine, through the courtesy of Dr. W. J. Morse. Spore suspensions were secured from vigorous cultures of each strain and these suspensions were sprayed upon the tomato plants by means of atomizers.

Thirty tomato plants were used in each experiment and these were divided into three similar lots of ten plants each. The plants averaged about ten inches tall. One lot of tomatoes was inoculated with strain I, a second

lot with strain II, and the third lot with strain III. The plants were placed in a large moist chamber at 10°C. to 15°C. immediately after inoculation, and allowed to remain there for a day. They were then transferred to a warm room in the greenhouse where conditions were better for normal growth. Evidences of infection were apparent within three to four days from the time of inoculation. Five to six days after inoculation the plants were again placed in the moist chamber at 15°C. to 25°C., and allowed to remain for two or three days so as to bring out the infected areas clearly and quickly.

The results of all trials were as uniform as could be expected and a brief, general description of the plants in one experiment, together with the accompanying photographs, will be considered as sufficient evidence for submission at this time. The plants were inoculated on January 3 and the first indications of infection (Jan. 7th) were small dead areas on the leaves of plants inoculated with strains II and III, and very slight wilting of leaf tips on plants inoculated with strain I.

The plants inoculated with strain I showed pronounced wilting of younger growths and several stem lesions on January 8, while plants inoculated with strains II and III showed no evidence of wilting or of stem lesions, but did have numerous spots on the lower leaves. The differences became more marked daily until all plants inoculated with strain I (from tomato) were dead, whereas those inoculated with strains II and III (from potato) were growing nicely and had shed their lower leaves so that no evidence of infection remained.

The cultures isolated from potato, when inoculated upon tomato, produce leaf spots on the lower, older leaves as shown in fig. 2, but do not produce the scalded and wilted appearance which is always considered so characteristic of late blight. The culture isolated from tomato produces typical late blight symptoms on tomato.

It might also be noted that sporulation occurred very sparingly in the spots produced by inoculation with strains II and III, even under very favorable conditions, but the fungus was repeatedly and easily isolated from such spots. Abundant spore production was readily secured from areas infected with strain I.

More detailed publications, covering various phases of this work, will be issued later.

PLATE XI

FIG. 1. Tomato plants six days after inoculation. Flats marked A and C contain plants inoculated with *Phytophthora infestans* from potato. Flat marked B contains plants inoculated with *P. infestans* isolated from tomato.

FIG. 2. Infected tomato leaves twelve days after inoculation. Leaf (A) was inoculated with *P. infestans* isolated from potato. Leaves (B) and (C) were inoculated with *P. infestans* isolated from tomato.

FIG. 1

FIG. 2

GIDDINGS AND BERG: POTATO AND TOMATO BLIGHT

THE "ICELESS REFRIGERATOR" AS AN INOCULATION CHAMBER

N. REX HUNT

WITH PLATE XII

It seems desirable to call attention to the possibility of using iceless refrigerators, so called, in place of bell jars or glass chambers for inoculation work with rusts. They are easily made and are cheap, convenient, readily moved, and there is practically no danger of breakage. The use of the iceless refrigerator was adopted following experiments to find a satisfactory method of inoculating Ribes with *Cronartium occidentale* during the summer at Washington, D. C., the heat being too intense for the use of the regular inoculation chambers. The refrigerator may be built any size desired and of such materials as are available. The type used by the Office of Forest Pathology is 20 inches wide, 1 foot deep and $2\frac{1}{2}$ feet high, made of 1 by 2 inch strips of wood (fig. 1). A large pan full of water sits on top of the frame (fig. 2). Under the conditions at Washington, D. C., unbleached muslin was found most satisfactory for covering. This should be washed to remove the natural oil and permit capillary action. An 18-inch strip covers each side (fig. 2). Yard wide strips cover the front and back and meet at the middle of the side strips, being held in place by safety pins at top and bottom (figs. 3 and 4). All four strips extend from inside the water pan to the floor. When the apparatus is to be used the cloth is thoroughly wet down and the pan filled with water. Thereafter sufficient water is drawn from the pan by capillary action to keep the cloth damp all over. When damp, the overlapping cloths stick together, making the whole covering practically insect proof.

On July 30, 1917, an iceless refrigerator was in use as an inoculation chamber on a cement walk out-doors on the north side of a greenhouse in the shade. At 2 o'clock the temperature inside the refrigerator was 85°F., outside it was 96°F., and in the greenhouse where the regular tight glass inoculation chambers were located it was 103°F. The plants which were in the iceless refrigerator during this period developed numerous infections. During the summer of 1917 the maximum temperature in the iceless refrigerator on hot days was usually 80 to 81° regardless of the higher and more variable temperatures elsewhere.

During the hot summer weather inoculated plants in tight glass inoculation chambers suffered much injury to the leaves, owing to excessive heat and stagnant air. No tendency toward this trouble has been observed in any single instance when using the iceless refrigerator. In the case of the latter, evaporation keeps the air inside moist, fresh and at a comparatively low even temperature, conditions which are much more

favorable to the host than those obtainable in the glass chambers. Experience, particularly with species of Coleosporium, has shown that inoculations made during periods when the temperature was higher than 80°F. could not be relied upon, even when all other conditions seemed favorable. During the winters of 1917-1918 and 1918-1919 the device has been used in the greenhouse in preference to all others with marked success. It has not been necessary to place them outside during hot weather. The success of various members of the Office of Forest Pathology in using iceless refrigerators for inoculations with various species of Coleosporium and Cronartium seems to warrant calling the attention of other workers to its possibilities.

OFFICE OF INVESTIGATIONS IN FOREST PATHOLOGY
BUREAU OF PLANT INDUSTRY
WASHINGTON, D. C.

ROSE M. TAYLOR

ERNST A. BESSEY

Miss Rose M. Taylor, a member of the American Phytopathological Society, was born near Marquette, Michigan, where the early years of her life were spent. Upon the completion of her public school training, Miss Taylor entered the University of Chicago, where foundation courses in botany were taken under Professors Coulter, Barnes, and Cowles.

Transferring then to the University of Michigan, her studies in botany were continued there. Studies upon fungi were taken up under Dr. C. H. Kauffman, in this way beginning a botanical friendship which lasted until her death. During summer vacations, collections of fungi were made in the region about her home and sent to the university. A short publication, "The Distribution of Mushrooms at Negaunee, Mich.,"[1] records observations made at this time. She was granted the degree of B.A. in 1908.

Miss Taylor was appointed Instructor in Botany at the Michigan Agricultural College, in 1909, a position which she held until her death, December 6, 1918, from influenza. Her interest and her teaching centered in plant pathology and she had full direction of the work in forest pathology.

During the period of her employment at the Michigan Agricultural College, she attended several summer sessions at the University of Michigan, obtaining the degree of M.A.

In the fall of 1917, she accompanied Dr. and Mrs. Kauffman to Colorado and the Pacific coast on a collecting trip for higher fungi.

[1]Rept. Mich. Acad. Sci. 12: 95–96. 1910.

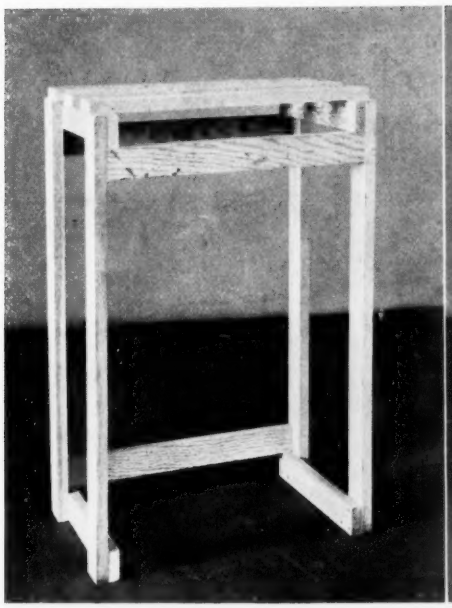

FIG. 1

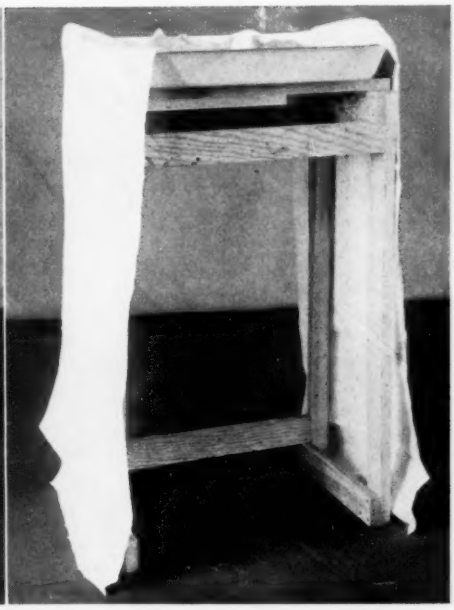

FIG. 2

FIG. 3

FIG. 4

HUNT: INOCULATION CHAMBER

An exceptionally able teacher and a keen student of human nature, she brought out the best qualities in her students and many young phytopathologists today look back to her training as invaluable.

MICHIGAN AGRICULTURAL COLLEGE.
EAST LANSING, MICHIGAN.

PHYTOPATHOLOGICAL NOTES

Advisory Board Conference at Birmingham. A conference of pathologists, horticulturists, botanists, and others interested in the problems relating to the growing, storage, and marketing of sweet potatoes and in the diseases of southern crops, especially cotton, corn, and tomatoes, was called by Prof. H. W. Barre of Clemson College, Commissioner for the South of the Advisory Board of American Plant Pathologists. The conference met at the Hotel Tutwiler, Birmingham, Alabama, in connection with the annual meeting of the Association of Southern Agricultural Workers, and was in session throughout February 26, 27 and 28. Forty-six persons were in attendance, representing the United States Department of Agriculture and thirteen southern states.

The discussion of sweet potato problems occupied the major part of the first two days of the conference, being participated in by pathologists, by horticulturists, and by those engaged in the practical work of growing, storing, and marketing the crop. Specialists appointed for the purpose led and directed the discussion, which covered all phases of the sweet potato industry from seed selection to the final marketing of the crop.

Mr. E. F. White, Extension Horticulturist of the Mississippi Experiment Station, was chosen leader in the coöperative work which the conference voted to undertake on problems of seed selection and propagation. Reports from several states showed that movements in the direction of some system of inspection and certification of sweet potato seed and plants are already under way on account of the frequent introduction of disease, both on seed and on plants. After full discussion a standing committee on inspection and certification was appointed, with Dr. W. A. Orton of the U. S. Department of Agriculture as chairman, to work out methods of inspection and to define standards of certification.

At the close of the discussion on sweet potatoes a committee of three was appointed, consisting of Prof. H. W. Barre, chairman, Pathologist and Director of the South Carolina Experiment Station; Prof. G. C. Starcher, Horticulturist at the Alabama Polytechnic Institute; and Mr. R. G. Hill, Market Specialist of the U. S. Department of Agriculture. This committee was directed to assume the leadership in coöperative work on sweet potato problems along the various lines marked out by the conference.

Following the consideration of sweet potato problems there was a brief discussion of some of the more important diseases of cotton, corn, and tomatoes, especial attention being given to corn root rots, which are of increasing importance throughout the South.

Canadian Plant Pathological Society. A Canadian Branch of the American Phytopathological Society has been formed. The organization hopes to unite Canadian plant pathologists and at the same time maintain a close connection with the parent organization. The plan of organization is much the same as the Pacific Division of the American Phytopathological Society.

Officers: President, J. E. Howitt, Professor of Botany, O. A. C., Guelph, Ont., Vice-president, W. A. McCubbin, Dominion Laboratory of Plant Pathology, St. Catherines, Ont.; Secretary-Treasurer, R. E. Stone, O. A. C., Guelph, Ont.; Councilors, P. A. Murphy, Dominion Laboratory of Plant Pathology, Charlottetown, P. E. I.; W. P. Frazer, Macdonald College, P. Q.

New location for forest pathology laboratory. The Laboratory of Forest Pathology of the Bureau of Plant Industry, U. S. Department of Agriculture, Dr. James R. Weir in charge, has been removed from Missoula, Montana to Spokane, Washington, where it will be permanently installed in a fire-proof building. The most intensive work of this laboratory is centered in the great white pine forests of Idaho. To promote pathological investigation in this region, a permanent field station will be established, also a forest pathological museum.

All future communications should be addressed to Laboratory of Forest Pathology, Spokane, Washington.

Personals. Dr. Arthur J. Mix, who has been assisting in war emergency work on the control of vegetable diseases for the U. S. Department of Agriculture during the past year, has returned to the position of associate professor of botany in the University of Kansas.

Dr. L. R. Hesler of Cornell University has entered the Department of Agriculture for a temporary period to assist in plant disease survey work.

Mr. Ira C. Hoffman, formerly assistant professor of horticulture in the College of Agriculture of Purdue University, has been appointed assistant pathologist in cereal disease investigations, Bureau of Plant Industry, and will take up work on the Fusarium rots of corn. Mr. Hoffman has recently received his discharge from the Army.

Mr. Marion Griffiths, who has been engaged in the smut control campaign of the U. S. Department of Agriculture in the state of Washington, under temporary appointment, has been appointed assistant pathologist in cereal disease investigations to assist in investigations of smut and other fungi, in the Washington, D. C., laboratory.

Mr. Julian G. Leach, who has been employed as an agent of the Bureau of Plant Industry and engaged in the breeding of cereals for rust resistance, at the University Farm, St. Paul, Minn., resigned March 15 to become assistant professor of botany at the Colorado College of Agriculture.

Mr. Emile Mardfin, formerly a student at Cornell University, has recently been discharged from the Army and has accepted an appointment as assistant pathologist in the Bureau of Plant Industry to assist in investigations of leaf rust of wheat and other cereals at Purdue University.

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COMPILED BY EUNICE R. OBERLY, LIBRARIAN, BUREAU OF PLANT INDUSTRY, AND FLORENCE P. SMITH, ASSISTANT

February, 1919

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Cladosporium, Fumago.

[1]This list includes references, both American and foreign, to the literature of plant pathology and mycology of interest to pathologists. Foreign references published since January 1, 1917, have been included beginning with the list appearing in v. 7. no. 3, June, 1917.

All authors are urged to cooperate in making the list complete by sending their separates and by making corrections and additions, and especially by calling attention to meritorious articles published outside of regular journals. Reprints or correspondence should be addressed to Miss E. R. Oberly, Librarian, Bureau of Plant Industry, U. S. Dept. of Agric., Washington, D. C.

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